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56) Documents cited in evaluating patentability:

DE 94 13 743 U1
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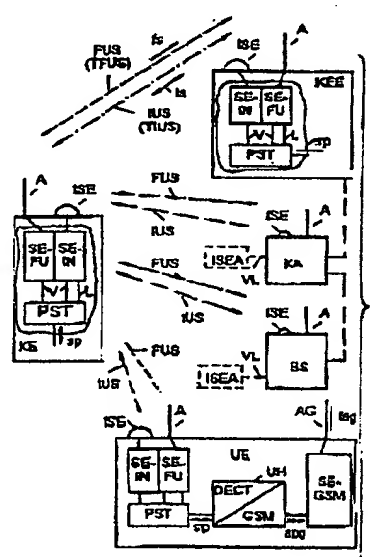
"Architekturen für ein DECT-Sende und Empfangsteil" [Architectures for a DECT-Transmission and Receiving Piece]:
Compare to: NTZ, Vol. 46, 1993, H. 10, pp. 754-757
A. MANN: Der GSM-Standard [The GSM-Standard] in Informatik-Spektrum [Computer Science Spectrum] 14, 1991, pp. 137-151

(54) **Method and communication system for reducing the radio transmissions in wireless communication systems**

(57) In the method according to the invention, a bidirectional infrared transmission path (IUS) is provided in addition to the bidirectional radio transmission path (FUS) between a communication system (K) and a wirelessly connected communication terminal (KE). During an exchange of information, the transmission quality of the bidirectional infrared transmission path (IUS) is continuously verified and, depending on the result of the verification, the exchange of information is directed over the bidirectional infrared transmission path (IUS) or over the bidirectional radio transmission path (FUS), whereby in the case of an exchange of information over the infrared transmission path (IUS), at least the radio transmitters (SE-FU) are deactivated. As a result, radio transmissions in a wireless communications system are reduced substantially and possible effects on the user caused by radio signals are avoided and average power consumption is reduced.



Description

Pico-cellular wireless communication systems are mostly implemented according to the DECT (Digital European Cordless Transmission) standard. In this DECT standard, which is described in the publication Nachrichtentechnik Elektronik [Communications Engineering Electronics] 42 (1992) Jan./Feb., No. 1, "Structure of the DECT Standard", pp. 23 through 29, the transmission protocol that is used on the bidirectional radio transmission path between a base station and the wirelessly connected communication terminals are specified, along with the physical properties of the transmitting and receiving systems that implement the radio transmission path. In this regard, the radio signals are transmitted over the radio transmission path at a transmission frequency of 1.9 GHz, i.e., in the microwave range. Pico-cellular wireless communication systems of this type with a limited range of approximately up to 200 meters are used primarily in private communication systems, such as branch telephone exchanges or telephone terminals, for example. In addition, it is known from the German DE 94 13 743 U1 that transmitting and receiving systems that implement an infrared transmission path can be provided in place of transmitting and receiving systems that implement each of the radio transmission paths. In the case of wireless communication systems with infrared transmission paths, only short transmission ranges can be achieved, and the applications are intended for closed rooms.

A portion of the users of pico-cellular wireless communication systems fear negative effects on the user of the radio signals in the microwave range that are given off by the transmitters during radio connections.

The task on which the invention is based consists in developing a method and a communication system to reduce the radio connections in pico-cellular wireless communication systems. The task is carried out with respect to the method by the features of patent Claim 1, and with respect to the communication system by the features in patent Claim 7.

Advantageous developments of the invention are the objects of the subclaims.

The essential aspect of the method according to Claim 1 is to be seen in the fact that in pico-cellular wireless communication systems, a bidirectional infrared transmission path is provided in addition to each bidirectional radio transmission path, and that during the exchange of information the transmission quality of the bidirectional infrared transmission path is continuously verified. Depending on the result of the verification, the exchange of information is directed over the bidirectional infrared transmission path or over the bidirectional radio transmission path, whereby in the case of an exchange of information over the infrared transmission path, at least the radio transmitters that implement the radio transmission path are deactivated.

During a current exchange of information over the bidirectional radio transmission path, the transmission quality of both of the bidirectionally directed radio transmission sub-paths of the infrared transmission path is continuously verified simultaneously, and if the transmission quality of one or both of the infrared transmission sub-paths is adequate, the exchange of information is directed over the bidirectional infrared transmission path and at least the radio transmitters of the bidirectional radio transmission path are deactivated Claim 2. During a current exchange of information over the bidirectional infrared transmission path, the transmission quality of both of the bidirectionally directed infrared transmission sub-paths of the infrared transmission path is continuously verified, and if the transmission quality of at least one of the infrared transmission sub-paths is not adequate, the exchange of information is directed over the bidirectional radio transmission path, whereby the transmission quality of the bidirectional infrared transmission path continues to be verified Claim 3.

According to an additional advantageous development of the method according to the invention, following receipt of radio signals transmitted over the radio transmission path, the exchange of information is directed over the radio transmission path Claim 4. This measure ensures that following the detection of an inadequate transmission quality of the infrared transmission path and a switchover to the radio transmission path in the given communication terminal or the given communication system, through the transmission of the radio signals to the wirelessly connected communication terminal or communication system, a redirection to the radio transmission path takes place in the latter as well.

Through the method according to the invention, particularly advantageous control of the radio transmission path with an additional infrared transmission path implemented in a pico-cellular wireless communication system is achieved, whereby through the continuous checking of the transmission quality of the infrared transmission path, the radio transmission path is activated only if the transmission quality of the infrared transmission path is no longer sufficient for reliable transmission of the digitized telephone signals. In an analogous way, the infrared transmission path is reactivated if the transmission quality of the infrared transmission path is again sufficient. This means that in closed rooms such as offices or living areas, for example, the wireless transmission of the digitized telephone signals is directed over infrared transmission paths, and outdoors or in other rooms not equipped with infrared means of transmission, the wireless transmission is automatically directed over a radio transmission path. Through the method according to the invention, during the exchange of information in pico-cellular wireless communication systems, the radio connections are substantially reduced by the switchover to additionally provided infrared transmission paths, and possible effects on the user of pico-cellular wireless communication systems due to the radio signals created during radio connections in the microwave range are reduced. A further advantage of the method according to the invention can be seen in the fact that with a reduction of the radio transmissions, the average power consumption in the communication terminals is lower because of the lower transmitting power of the infrared transmission path in comparison with the radio transmission path, and consequently, smaller energy storage devices can be used or longer operating time is achieved with the same energy storage device. Smaller chargeable or non-chargeable energy storage devices also reduce the weight and the size of the communication terminal, even taking into account the additional components that implement the bidirectional infrared transmission path.

Disclosed in the further Claims 8 through 18 are particularly advantageous developments of a communication system for reducing radio transmissions in a pico-cellular wireless communication system, whereby infrared transmitting/receiving systems are provided for the implementation of the infrared transmission path, and priority means are provided for the verification of the transmission quality of the infrared transmission path and for the redirection of the exchange of information from the infrared transmission path to the radio transmission path and vice-versa.

In the following, the method according to the invention will be explained in more detail with the aid of a block diagram and a flow chart. The following are shown:

Fig. 1, a pico-cellular wireless communication system implemented according to the invention, and

Fig. 2, in a flow chart, the method according to the invention that is implemented in the components of the pico-cellular wireless communication system according to **Fig. 1**.

The block diagram shows a communication terminal KE that can be connected in wireless fashion to one of the communication systems K. The communication terminal KE is representative of several communication terminals that can be assigned to one of the communication systems K shown. A communication system K is implemented via an additional communication terminal KEE, a base station BS of a wireless telephone system, a communication installation KA – specifically, a telephone branch exchange – or via a system converter UE. The additional communication terminal KEE is connected by way of example – indicated by dotted lines – with the communication installation KA. The additional communication terminal KEE represents, for example, a telephone terminal of a public or private telephone network, whereby the additional communication terminal KEE is connected with a public or private communication installation or telephone installation.

By way of example, the represented base station BS can also be connected with a communication installation KA– indicated by dotted lines. Wireless communication terminals can be connected with the base station BS.

For the embodiment, let us assume that the represented wireless communication terminal KE is assigned to the wireless additional communication terminal KEE. The components needed in the communication terminal KE and the additional communication terminal KEE for implementing the method according to the invention are explained in the following. Both the communication terminal KE and the additional communication terminal KEE have one antenna A each, which are wirelessly connected via the bidirectional radio transmission path FUS. The radio transmission path FUS is

[formed] by two bidirectionally directed radio transmission sub-paths (TFUS) – indicated by a designation placed in parentheses in **Fig. 1**. Radio signals fs, according to the DECT standard, for example, are transmitted bidirectionally over the radio transmission path FUS, i.e., between the communication terminal KE and the additional communication terminal KEE. According to the DECT standard, the radio signals fs have a frequency of 1835 to 1932 MHz, depending on the transmission direction and the transmission channel being used. In addition, the digitized voice signals are inserted into a stream with a time-multiplexed structure and are transmitted to the wirelessly connected communication systems K. To implement the radio transmission path FUS, the antenna A is connected with a transmitter/receiver system SE-FU. In it, the incoming digital voice signals sp, which are time-multiplex oriented in accordance with the DECT standard, are converted into radio signals fs that are in accordance with the DECT standard, and vice-versa. Implementations of such transmitter/receiver systems SU-FU [sic] are described in the publication NTZ, Volume 46, 1993, No. 10, pp. 754 to 757, "Architectures for a DECT transmitter and receiver unit: A comparison". Alternatively, the radio transmitter/receiver system SE-FU and the antenna A can be implemented not in accordance with the DECT standard, but rather in accordance with additional transmission protocols and physical properties that have been tuned to a pico-cellular communication system.

In addition, provided in both the communication transmitter KE as well as in the additional communication terminal KEE is an infrared transmitter/receiver unit ISE that implements a bidirectional infrared transmission path IUS. An infrared transmission path IUS is formed by two bidirectionally directed infrared transmission sub-paths (TIUS) – indicated by a designation placed in parentheses in **Fig. 1**. It is known that an infrared transmitter/receiver unit ISE can be implemented by means of an infrared transmitter diode and infrared receiver diode. The infrared receiver unit can alternatively be implemented as an independent infrared transmitter/receiver unit ISEA, i.e., one that is remote from the communication system K – indicated by dotted blocks in **Fig. 1**. The remote infrared transmitter/receiver unit ISEA is advantageously used in communication systems in which the communication system K and the communication terminal KE are located in different rooms or buildings. The integrated and the remote infrared transmitter/receiver systems ISE, ISEA are each connected with an infrared transmitter/receiver system SE-IN. In this infrared transmitter/receiver system SE-IN, the infrared signals ist [sic] that can be transmitted over the infrared transmission path IUS are modulated by the digital voice signals sp that are formed with a time-multiplex structure in accordance with the DECT standard, or are demodulated by the infrared signals is that are transmitted over the infrared transmission path IUS.

Each of the transmitter/receiver systems SE-FU, SE-IN is connected via a bidirectional connection V with a priority control PST. Verified in this priority control PST on the one hand are the redirection of the incoming or outgoing digitized voice signals sp, which are formed in accordance with the DECT standard, over the infrared transmission path IUS or the radio transmission path FUS, as well as, along with the infrared transmitter/receiver system SE-IN, the transmission quality of the bidirectional infrared transmission path IUS. This is brought about, for example, through the fact that the level of the received infrared signals is in the infrared transmitter/receiver system SE-IN is measured, and the result of the measurement is transmitted over an additional connection L to the priority control PST, where it is evaluated. If it exceeds or falls below a predefined level of the infrared signals is, the current exchange of information is directed either over the infrared transmission path IUS or the radio transmission path FUS. Alternatively, the measurement of the ratio of the wanted signal to the noise signal of the received infrared signals is can also be used for the measurement of the transmission quality. In that case, the result of the measurement is likewise transmitted via the additional connection L to the priority control PST, where it is evaluated. If the ratio of the wanted signal to the noise signal is adequate, the exchange of information is directed over the infrared transmission path IUS, and if the ratio is not adequate, the current exchange of information is directed over the radio transmission path FUS. To do this, a switchover system – not shown – is provided in the priority control PST. In addition, monitoring is carried out in the priority control PST as to whether radio signals fs are being received over the radio transmission path FUS. If so, then the outgoing digital voice signals fs, which are formed according to the DECT standard, are also directed over the radio transmission path FUS. This switchover is necessary,

because if radio signals fs are being received, it can be assumed that inadequate transmission quality of the infrared transmission path IUS is present at the wirelessly connected communication system K or the communication terminal KE, and the exchange of information has been directed onto the radio transmission path FUS.

In terms of the method according to the invention, the communication installation KA, the base station BS and the system converter UE are constructed in the same way as the additional communication terminal KEE, i.e., with an antenna A, an infrared transmitter/receiver unit ISE, an infrared transmitter/receiver system SE-IN, a radio transmitter/receiver system SE-FU and a priority control PST.

Inside the system converter UE, the priority control is connected with a conversion unit UH. Inside this conversion unit UH, for example, the voice signals sp that are formed according to the DECT standard are converted into voice signals spg that are formed according to the GSM standard, whereby the digitized voice signals remain unchanged per se and are merely taken from a standardized transmission frame, for example, and inserted into a different standardized transmission frame, for example. The major properties of the GSM standard are described in the publication Informatikspektrum [Information technology spectrum] 14 (1991) June, No. 3, pp. 137 – 152 "The GSM Standard". According to the GSM standard, the digitized voice signals are likewise inserted into transmission frames with a time-multiplex structure, whereby the frame length is matched to the transmission speed of 890 to 960 MHz. This conversion unit UH is advantageously implemented by means of a microprocessor unit, since digital DECT voice signals sp are being converted into digital GSM voice signals spg. The conversion unit UH is connected with a transmitter/receiver system SE-GSM that is implemented according to the GSM standard. Inside this transmitter/receiver system SE-GSM, the digital voice signals sp that have a time-multiplex structure according to the GSM standard are converted into high frequency radio signals fsg according to the GSM standard, and are transmitted over an antenna AG provided for this purpose to an additional communication system, not shown, which is wirelessly connected with the system converter UE and which is part of a communication system that is implemented according to the GSM standard. In an analogous way, radio signals fsg that are received according to the GSM standard are converted into digital, GSM-standard voice signals spg. The system converter is used especially advantageously in vehicles in order to obtain, by means of a communication terminal implemented according to the DECT standard, access to a wireless macro-cellular communication system implemented according to the GSM standard, for example, whereby the wireless macro-cellular communication system is matched to the requirements of the mobile vehicle in terms of transmission power and method (e.g., handover at a speed of 200 kmh). When this is done, the exchange of information inside the vehicle is independently directed over the infrared transmission path IUS, which exerts slight effects on the user, and in the short range outside the vehicle over the radio transmission path FUS. In addition, as was explained earlier the reduction of the radio transmissions reduces the average power consumption, as a result of which lighter, smaller communication terminals can be designed or longer operating times or longer talk times can be achieved during battery or accumulator operation. The exchange of information is accomplished simultaneously over the wireless connection to the communication system implemented according to the GSM system via the system converter UH and the GSM transmitter/receiver system SE-GSM. The antenna A of the GSM transmitter/receiver system SE-GSM and the antenna AG of the transmitter/receiver system SE-FU are be [sic] located outside of the vehicle. Through the use of the system converter UE, along with substantially reducing the possible effect on the user of the radio signals – in the microwave range – that are formed in the radio transmission units, the effect on the vehicle electronics (e.g., in the airbag) is substantially reduced as well. Alternatively, system converters UE can be implemented with a conversion unit and a transmitter/receiver system that are matched to other wireless communication systems that work according to other standards or transmission protocols and other transmission properties. Provided for the implementation of the GSM or alternative transmitter/receiver systems SE-GSM are circuitry- or programming-based components that are placed in the corresponding wireless communications systems. A microprocessor system is advantageously used for converting the digitized DECT voice signals sp into GSM or alternative digital voice signals spg.

Fig. 2 shows a flow chart, which is basically self-explanatory, that is implemented in the priority controls PST, which are implemented by means of a microprocessor, for example, and to some extent in the infrared transmitter/receiver systems IUS. The sequence that is shown, which is advantageously implemented by means of programming, is started at the beginning of an exchange of information, i.e., at the start of a voice connection, in each of the relevant communication terminals KE or communication systems K and is repeated cyclically in the sense of a sampling of the measured values that indicate the transmission quality of the infrared transmission path IUS until the end of the exchange of information. Possible as an alternative – not shown – are interrupt-controlled programming-based implementations, whereby the sequence or a subsequence is started as a result of a measured value that exceeds or falls below a predefined value in dependency on a current exchange of information and is ended after the exchange of information.

Patent Claims

1. Method for reducing the radio transmissions during the exchange of information in a pico-cellular wireless communication system, in which a communication system (K) can be connected over one pico-cellular, bidirectional radio transmission path with at least one wireless communication terminal (KE),

   – in which provided in addition to each bidirectional radio transmission path (FUS) is a bidirectional infrared transmission path (IUS),

   – in which during an exchange of information the transmission quality of each bidirectional infrared transmission path (IUS) is continuously verified and, depending on the result of the verification, the exchange of information is directed over

     – the bidirectional infrared transmission path (IUS) or

     – the bidirectional radio transmission path (FUS),

   whereby during an exchange of information over the infrared transmission path (IUS), at least the radio transmitter systems (SE-FU) that implement the radio transmission path (FUS) are deactivated.

2. Method according to Claim 1, characterized in that during a current exchange of information over the bidirectional radio transmission path (FUS), the transmission quality of both of the bidirectionally directed infrared transmission sub-paths (TIUS) of the infrared transmission path (TIUS) [sic] is continuously verified simultaneously, and that if the transmission quality of one or both of the infrared transmission sub-paths (TIUS) is adequate, the exchange of information is directed over the bidirectional infrared transmission path (IUS), whereby at least the radio transmitters (SE-FU) of the bidirectional radio transmission path (FUS) are deactivated.

3. Method according to Claim 1, characterized in that during a current a current exchange of information over the bidirectional infrared transmission path (IUS), the transmission quality of both of the bidirectionally directed infrared transmission sub-paths (TIUS) of the infrared transmission path (IUS) is continuously verified, and that if the transmission quality of at least one of the two infrared transmission sub-paths (TIUS) is not adequate, the exchange of information is directed over the bidirectional radio transmission path (FUS), whereby the transmission quality of the bidirectional infrared transmission path (IUS) continues to be verified.

4. Method according to one of the Claims 1 through 3, characterized in that following receipt of radio signals (fs) transmitted over the radio transmission path (FUS), the exchange of information is directed over the radio transmission path (FUS).

5. Method according to one of the Claims 1 through 4, characterized in that in the communication system (K), pico-cellularly formed information (sp) is converted into micro- or macro-cellularly formed information (spg) and vice-versa, and that with the aid of additional transmitting/receiving means (AG, SE-GSM), the converted information (spg) is wirelessly transmitted to or received from a micro- or macro-cellular wireless communication system.

6. Method according to one of the Claims 1 through 5, characterized in that the pico-cellular wireless communication system is implemented according to the DECT standard.

7. Communication system for reducing the radio transmissions during the exchange of information in a pico-cellular wireless communication system, with at least one communication terminal (KE) that can be connected with a pico-cellular radio transmission path (FUS), whereby provided in the communication system (K) and the at least one communication terminal (KE) are radio transmission means (A, SE-FU) that implement a pico-cellular, bidirectional radio transmission path (FUS),

- in which additionally provided in both the communication system (K) and the at least one communication terminal (KE) are infrared transmission means (ISE, SE-IN) and priority means (PST) that implement a bidirectional infrared transmission path (IUS), designed in such a way
- that during an exchange of information the transmission quality of each bidirectional infrared transmission path (IUS) is continuously verified and, depending on the result of the verification, the exchange of information is directed over
  - the bidirectional infrared transmission path (IUS) or
  - the bidirectional radio transmission path (FUS),

whereby during an exchange of information over the infrared transmission path (IUS), at least the radio transmitter systems (SE-FU) that implement the radio transmission path (FUS) are deactivated.

8. Communication system according to Claim 7, characterized in that the communication system (K) and the at least one communication terminal (KE) are designed in such a way that during a current exchange of information over the bidirectional radio transmission path (FUS), the transmission quality of both of the bidirectionally directed infrared transmission sub-paths (TIUS) of the infrared transmission path (IUS) is continuously verified simultaneously with the aid of the priority means (PST) and a part of the infrared transmission means (SE-IN), and that if the transmission quality of one or both of the infrared transmission sub-paths (TIUS) is adequate, the exchange of information is directed over the bidirectional infrared transmission path (FUS) [sic], whereby at least the radio transmitters (SE-FU) of the bidirectional radio transmission path (FUS) are deactivated.

9. Communication system according to Claim 7, characterized in that the communication system (K) and the at least one communication terminal (KE) are designed in such a way that during an exchange of information over the bidirectional infrared transmission path (IUS), the transmission quality of both of the bidirectionally directed infrared transmission sub-paths (TIUS) of the infrared transmission path (IUS) is continuously verified simultaneously with the aid of the priority means (PST) and the infrared transmission means (ISE, SE-IN), and that if the transmission quality of at least one of the infrared transmission sub-paths (TIUS) is not adequate, the exchange of information is directed over the bidirectional radio transmission path (FUS), whereby the transmission quality of the bidirectional infrared transmission path (IUS) continues to be verified.

10. Communication system according to one of the Claims 7 through 9, characterized in that the communication system (K) and the at least one communication terminal (KE) are designed in such a way that following receipt of radio signals (fs) transmitted over the radio transmission path (FUS), the exchange of information is directed over the radio transmission path (FUS).

11. Communication system according to one of the Claims 7 through 10, characterized in that the infrared transmission means (ISEA) assigned to the communication system (K) are located separate from the communication system (K) and are connected with it by means of connecting lines (VL).

12. Communication system according to Claim 11, characterized in that the separate infrared transmission means (ISEA) are located in the main area of use of the wireless communication terminals (KE).

13. Communication system according to one of the Claims 7 through 12, characterized in that the communication system (K) is implemented by means of a communication terminal connected to a communication installation (KA).

14. Communication system according to one of the Claims 7 through 12, characterized in that the communication system (K) is implemented by means of a base station (BS) of a wireless communication system.

15. Communication system according to one of the Claims 7 through 12, characterized in that the communication system (K) is implemented by means of a communication installation (KA).

16. Communication system according to one of the Claims 7 through 12, characterized in that the communication system (K) is implemented by means of a system converter (UE), that the system converter (UE) is provided with means (UH) for converting the pico-cellularly formed information (sp) into micro- or macro-cellularly formed information (spg) and vice-versa, and that provided in the system converter (UE) are additional transmitting/receiving means (AG, SE-GSM) for wireless connection to a micro- or macro-cellular wireless communication system.

17. Communication system according Claim 16, characterized in that the micro- or macro- cellular wireless communication system is implemented according to the GSM standard.

18. Communication system according to one of the Claims 7 through 17, characterized in that the pico-cellular wireless communication system is implemented according to the DECT standard.

2 page(s) of drawings follow

FIG 1

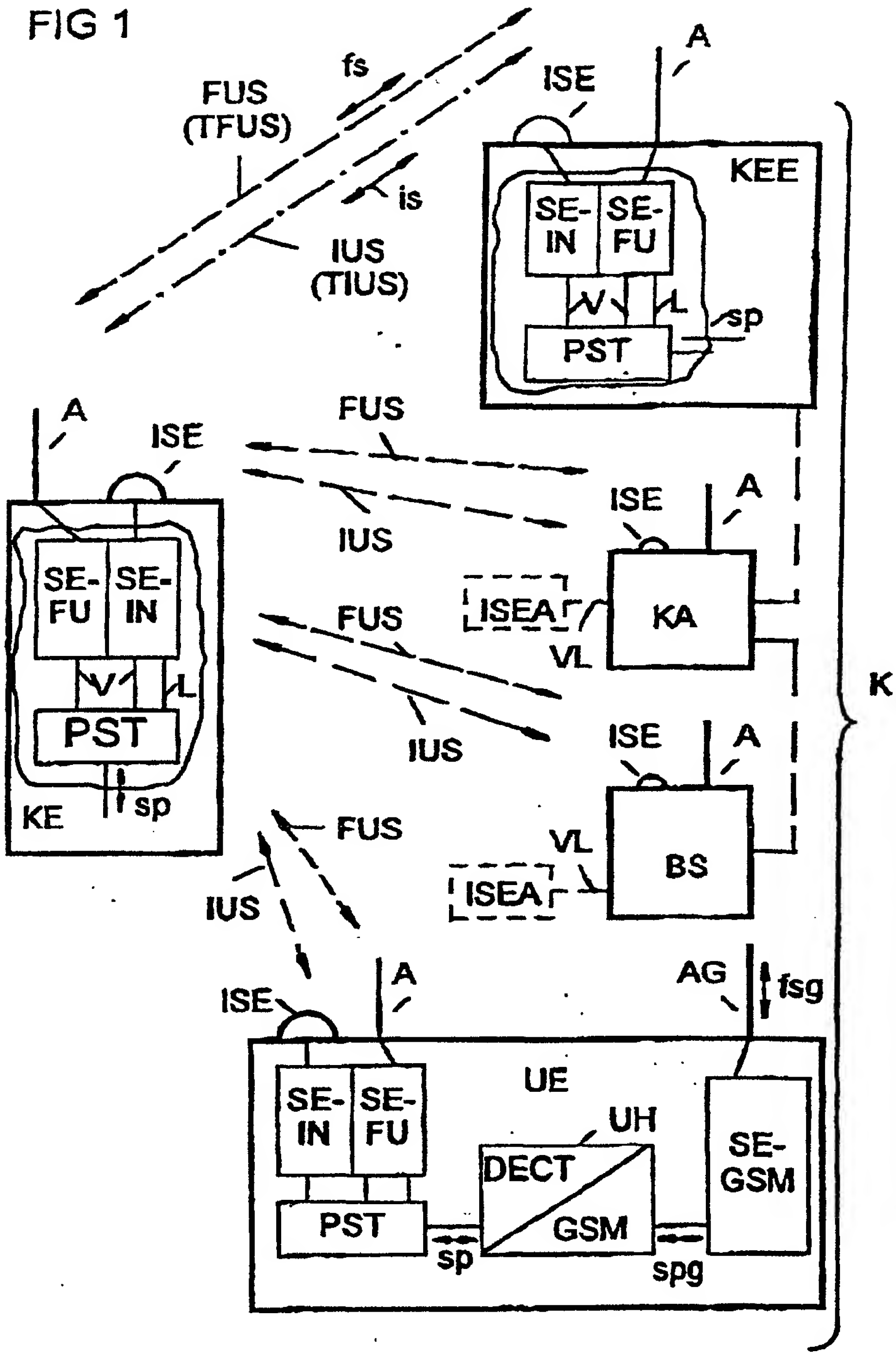


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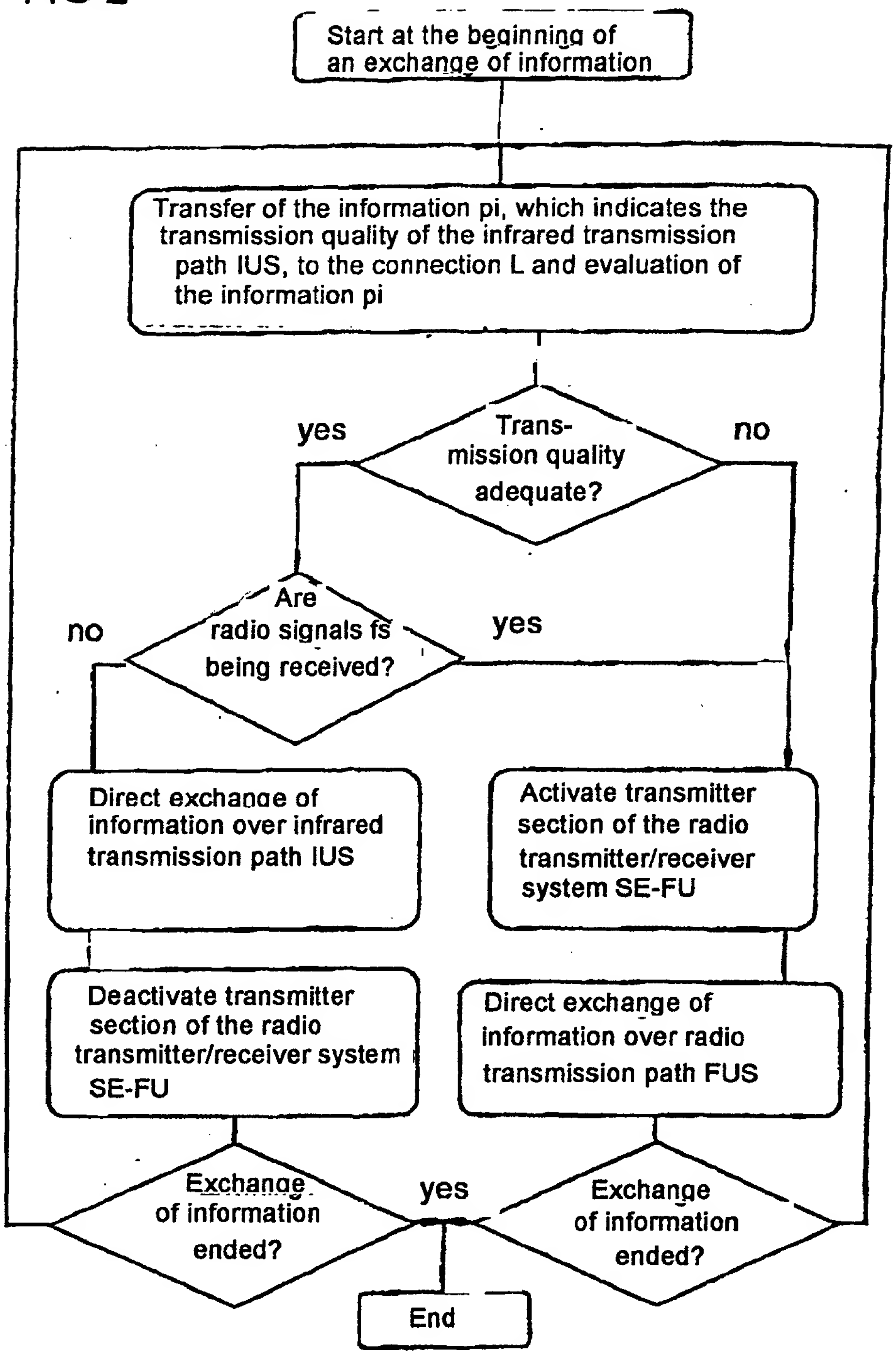
FIG 2


Start at the beginning of an exchange of information
Transfer of the information pi, which indicates the transmission quality of the infrared transmission path IUS, to the connection L and evaluation of the information pi
yes
Trans-mission quality adequate?
no
Are radio signals fs being received?
no
yes
Direct exchange of information over infrared transmission path IUS
Activate transmitter section of the radio transmitter/receiver system SE-FU
Deactivate transmitter section of the radio transmitter/receiver system SE-FU
Direct exchange of information over radio transmission path FUS
Exchange of information ended?
yes
Exchange of information ended?
End